three codes predicted different improvement levels). To summarize, it is believed that the present GA-based procedure can be used for solving rotorcraft–related problems of a practical nature.

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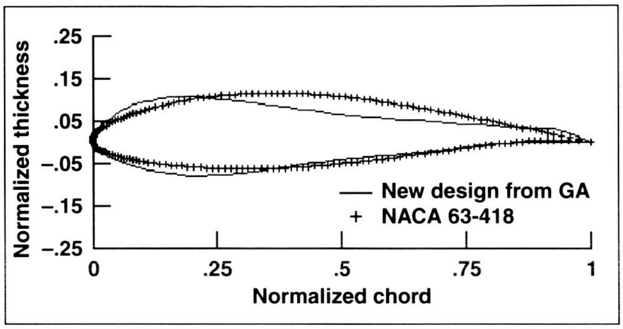

Fig. 1. NACA 63-418 design and new, genetic-algorithm-based design.

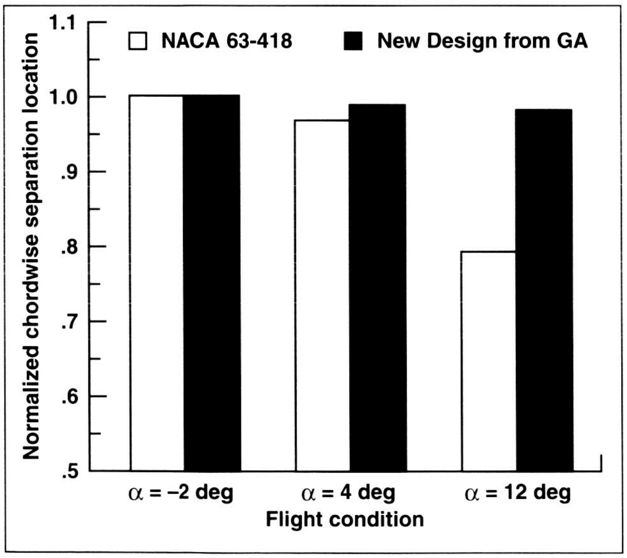

Fig. 2. Upper surface separation locations: angle of attack = 12 degrees (NACA 63-418 design and new design).

Overset Structured Grids for Unsteady Aerodynamics

Robert L. Meakin

The Department of Defense is supporting the development of robust adaptive refinement methods for unsteady geometrically complex moving body problems by means of the High Performance Computing Modernization Program (HPCMP) Initiative known as CHSSI. The object of the work is to exploit the computational advantages inherent in structured data to solve this important class of problems on parallel scalable computer platforms.

The physical domain of complex problems is decomposed into near-body and off-body regions. The near-body domain is discretized with "Chimera" overset grids that need extend only a short distance into the field. The off-body domain is discretized with overset structured Cartesian grids (uniform) of varying levels of refinement. The near-body grids resolve viscous boundary layers and other flow features expected to develop near body surfaces. Off-body grids automatically adapt to the proximity of near-body components and evolving flow features. The adaptation scheme automatically maintains solution accuracy at the resolution capacity of the near-body system of grids. The approach is computationally efficient and has high potential for scalability. Grid components are automatically organized into groups of equal size, which facilitates parallel scale-up on the number of groups requested. The method has been implemented in the computer program known as OVERFLOW-D.

For example, OVERFLOW-D was used in FY99 to obtain a time-accurate simulation of the V-22 tilt-rotor aircraft in high-speed cruise conditions. Temporal resolution of the simulation provided 2,000 time-steps per revolution of the rotor blades. Nearly 30 million grid points are used to spatially resolve the problem domain. An important result of the simulation is the capture of the rotor-tip vortices as part of the solution. As indicated in the figure, the vortices are evident in the field a full body length downstream of rotors. The simulation was carried out using 65 processors on an IBM-SP. Post-process analysis of the large unsteady data set was carried out on an SGI Origin 2000.

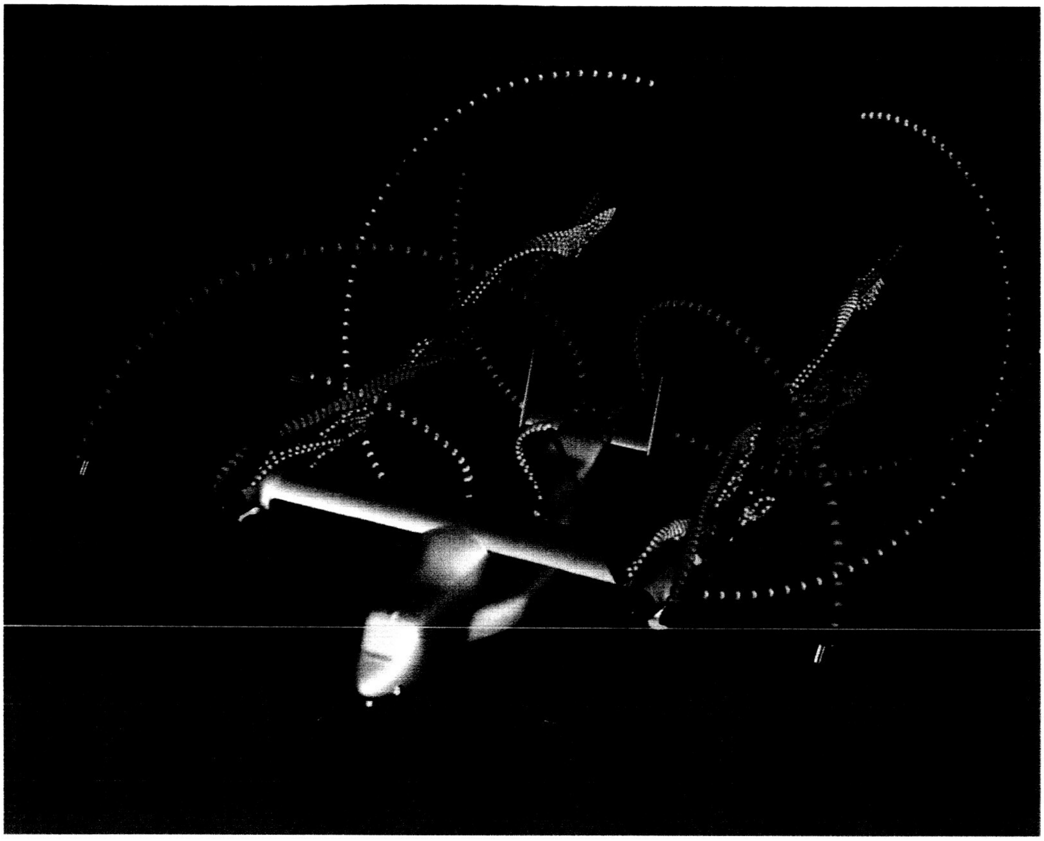

Fig. 1. The V-22 rotor-wake system is visualized in a post process where filaments of particles are released from inboard and outboard blade tips every 25 time-steps.

The V-22 result is significant in several respects. Accurate simulation of the rotor wake system is important in predicting rotor-airframe interactional dynamics, as well as aircraft acoustics. Combined with existing flight data and scheduled tunnel data, the result provides the basis for demonstrating design-to-flight analysis capability for general tilt-rotor aircraft. The result is a high-fidelity baseline data-set that can be used to evaluate future tilt-rotor concepts such as variable-diameter tilt rotors, quadrotors, and future defense transport tilt rotor configurations. The capabilities illustrated by this simulation support important defense and civil priorities relating to rotary-wing aircraft.

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